CHAPTER 15

INHERITANCE

MULTIPLE CHOICE QUESTIONS

Each question has four possible answers. Circle the correct answer

(1) The branch of Biology that deals with inheritance:

(a) Physiology (b) Ecology (c) Pharmacology (d) Genetics

(2) The chromosomes carry the units of inheritance called:

(a) Loci (b) Dominance (c) Genes (d) Traits

(3) In humans, the number of pairs of homologous chromosomes:

(a) 21 (b) 22 (c) 23 (d) 24

(4) DNA wraps around histone proteins and forms round structures, called:

(a) Chromatin (b) Chromosome (c) Nucleolus (d) nucleosomes

(5) Watson and Crick proposed the DNA model in:

(a) 1951 (b) 1953 (c) 1955 (d) 1957

(6) In DNA molecule, adenine always pairs with:

(a) Guanine (b) Cytosine (c) Thymine (d) Uracil

(7) How many hydrogen bonds are present between cytosine and guanine?

(a) One (b) Two (c) Three (d) Four

(8) The locations or positions of genes on chromosomes:

(a) Loci (b) Traits (c) Inheritance (d) Nucleotides

(9) How many types of nucleotides are present in DNA?

(a) 1 (b) 2 (c) 3 (d) 4

(10) The specific combination of genes in an individual:

(a) Genotype (b) Phenotype (c) Dominance (d) Recessive

(11) How many plants were used by Mendel in his experiments?

(a) 26,000 (b) 28,000 (c) 30,000 (d) 32,000

(12) The term true breeding means:

(a) Heterozygous (b) Genotype (c) Phenotype (d) Homozygous

(13) Mendel obtained how many round seeds in monohybrid cross?

(a) 4784 (b) 5474 (c) 7454 (d) 4555

(14) Phenotypic ratio of monohybrid cross:

(a) 3:1 (b) 2:1 (c) 9:3:3:1 (d) 1:2:1

(15) **Mendel obtained how many round yellow seed plants in dihybrid cross?**
(a) 32 (b) 101 (c) 108 (d) 315

(16) **The situation where two different alleles of a gene pair express themselves completely is called:**
(a) Co-dominance (b) Over dominance
(c) Incomplete dominance (d) None of these

(17) **Which genotype represents blood group A?**
(a) I^AI^A (b) I^Ai (c) Both a and b (d) None of these

(18) **Date of birth of C. de Buffon:**
(a) 1707 (b) 1710 (c) 1713 (d) 1716

(19) **Date of death of J. de Lamarck:**
(a) 1740 (b) 1742 (c) 1744 (d) 1829

(20) **Date of birth of Charles Darwin:**
(a) 1802 (b) 1808 (c) 1809 (d) 1810

ANSWER KEY

Q.No.	Ans	Q.No.	Ans	Q.No.	Ans	Q.No.	Ans	Q.No.	Ans
1	d	2	c	3	c	4	d	5	b
6	c	7	c	8	a	9	d	10	a
11	b	12	d	13	b	14	a	15	d
16	a	17	c	18	a	19	d	20	c

SHORT QUESTIONS

Q. No. 1 Define genetics.

GENETICS

The branch of biology which deals with the study of inheritance is called genetics.

Q. No. 2 What do you mean by inheritance?

INHERITANCE

Inheritance means the transmission of characteristics from parents to offspring.

Q. No. 3 What are traits?

TRAITS

The characteristics which are transferred from parents to offsprings are called traits.

Examples:

In man following are all inheritable traits:

- Height
- Colour of the eyes
- Intelligence

Q. No. 4 How do parents inherit characteristics>

INHERITANCE OF CHARACTERISTICS

Parents pass characteristics to their young through gene transmission. Equal numbers of chromosomes from each parent are combined during fertilization. The chromosomes carry the units of inheritance called the genes)

Q. No. 5 What are genes?

GENES

The genes are called units of inheritance that transmit traits from parents to offsprings.

Q. No. 6 Does the dominant allele affect the nature of recessive allele?

EFFECT ON RECESSIVE ALLELE

The dominant allele only suppresses the expression of recessive allele. It does not affect its nature.

Q. No. 7 How many pea plants were used by Mendel in his experiments?

NUMBER OF PEA PLANTS

Mendel used 28,000 pea plants in his experiments.

Q. No. 8 What does the term true breeding mean?

TRUE BREEDING

The term true breeding means homozygous.

Q. No. 9 How do variations caused by combinations of chromosomes?

VARIATIONS BY COMBINATIONS OF CHROMOSOMES

Variations are caused by different combinations of chromosomes in gametes and then in zygote.

Example:

In the case of humans, the possible number of chromosomal combinations at fertilization is 70,368,744,177,664. In other words, a couple can produce more than 70 trillion genetically different children.

LONG QUESTIONS

Q. No. 1 Write a note on chromosomes.

CHROMOSOMES

Genes consist of DNA. They contain specific instructions for protein synthesis.

Introduction:

Chromosomes are thread like structures that are present in the nucleus of the cell and become visible only at the time of cell division.

Specific Number:

The body cells have a constant number of paired chromosomes.

Homologous Chromosomes:

The two chromosomes of a pair are known as homologous chromosomes. In human body cells, there are 23 pairs of homologous chromosomes for a total of 46 chromosomes.

Gametes:

During meiosis, the two members of each chromosome pair separate and each of them enters one gamete.

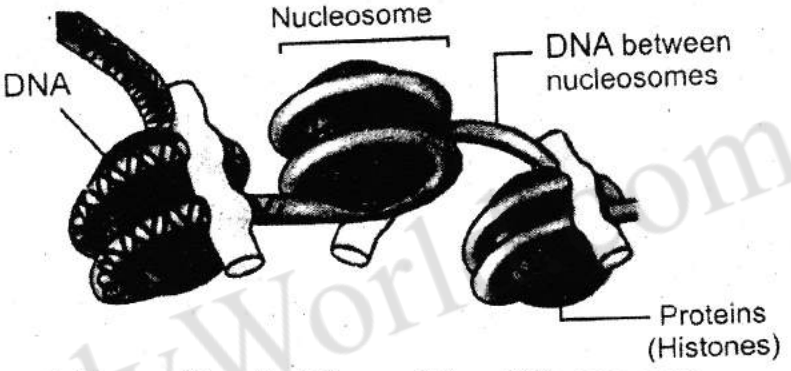


Figure: Chemical Composition of Chromosome

Chemical Composition of Chromosomes:

Chromatin:

Chromosome is made of chromatin material. Chromatin is a complex material, made of:

- DNA
- Proteins (mainly histone proteins)

Nucleosomes:

DNA wraps around histone proteins and forms round structures, called nucleosomes. DNA is also present between nucleosomes. In this way, the nucleosomes and the DNA between them look like "beads on a string".

Typical Structure:

The fibres consisting of nucleosomes condense into compact forms and get the structure of chromosomes.

Q. No. 2 Describe Watson and Crick model of DNA

WATSON AND CRICK MODEL OF DNA

Introduction:

In 1953, James Watson and Francis Crick proposed the structure for DNA.

Double Helix Structure:

According to the Watson-Crick model, a DNA molecule consists of two polynucleotide strands. These strands are coiled around each other in the form of a double helix.

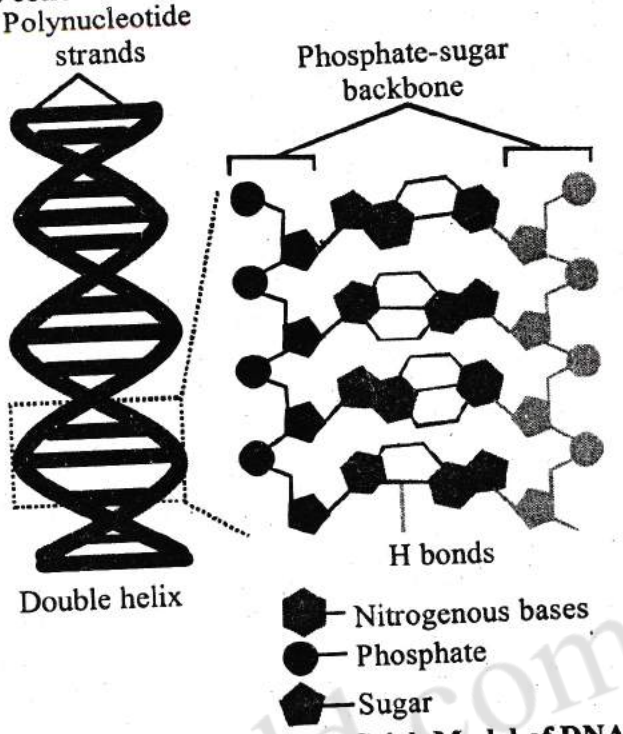


Figure: The Watson and Crick Model of DNA

Phosphate-Sugar Backbone:

There is a phosphate-sugar backbone on the outside of double helix.

Nitrogenous Bases:

The nitrogenous bases are on the inside of the double helix. In double helix, the nitrogenous bases of opposite nucleotides form pairs through hydrogen bonds.

Specific Pairing:

The pairing of nucleotides is highly specific. The nitrogenous base adenine of one nucleotide forms pair with the thymine of opposing nucleotide, while cytosine forms pair with guanine.

Hydrogen Bonds:

There are two hydrogen bonds between adenine and thymine while there are three hydrogen bonds between cytosine and guanine.

Q. No. 3 Write a note on DNA replication.

DNA REPLICATION

Introduction:

Before a cell divides, its DNA is replicated (duplicated). It is done to make the copies of the chromatids of chromosomes.

Mechanism of Replication:

Uncoiling Of DNA:

During replication, the DNA double helix is unwound and the two strands are separated, much like the two sides of a zipper.

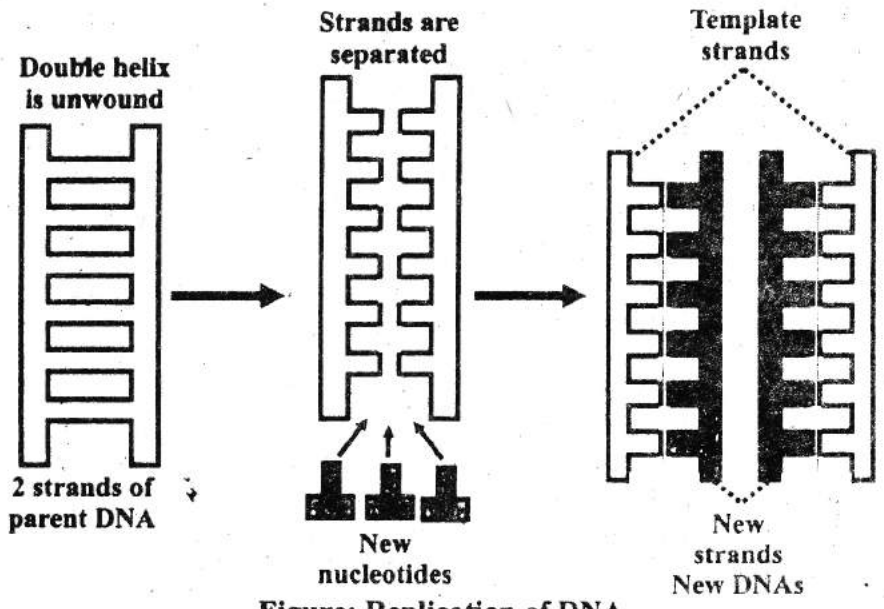


Figure: Replication of DNA

Formation of Template:

Each strand acts as a template to produce another strand.

Pairing of Nucleotides:

The DNA template nitrogenous bases make pairs with the nitrogenous bases of new nucleotides. In this way, both template strands make new polynucleotide strands in front of them.

New DNA Molecule:

Each template and its new strand together then form a new DNA double helix, identical to the original.

Q. No. 4 Explain, how does the DNA of chromosome work?

WORKING OF CHROMOSOMAL DNA

Genetic Material:

DNA is the genetic material. It contains the instructions to direct all the functions of cells. It performs its role by giving instructions for the synthesis of specific proteins.

Role of Proteins:

Some proteins perform structural roles while the others act as enzymes to control all biochemical reactions of cells.

DNA Control:

In this way, whatever a cell does, is actually controlled by its DNA. In other words, DNA makes the characteristic or trait of cell or organism.

Expression of Trait:

The traits are made by specific proteins. Specific proteins have specific number and sequence of their amino acids. DNA controls this sequence of amino acids by the sequence of its nucleotides. During protein synthesis, the sequence of DNA nucleotides decides that what will be the sequence of amino acids.

Transcription:

The specific sequence of DNA nucleotides is copied in the form of messenger RNA (mRNA) nucleotides. This process is called transcription.

Translation:

The mRNA carries the sequence of its nucleotides to ribosome. The ribosome reads this sequence and joins specific amino acids, according to it, to form protein. This step is known as translation.

Gene:

The part of DNA (sequence of nucleotides) that contains the instructions for the synthesis of a particular protein is known as a gene.

Number:

DNA of each chromosome contains thousands of genes.

Pairing:

Like chromosomes, genes also occur in pairs, one on each homologous chromosome.

Loci:

The locations or positions of genes on chromosomes are known as loci (Singular. locus).

Gene-Trait Relationship:

Each gene determines a particular trait in an organism. Each individual carries at least one pair of genes for each trait.

Representation:

For convenience, pairs of genes are represented by a letter or symbol. Both members of a gene pair may be the same in some individuals (a condition which we may represent as AA or aa or BB) and different in others (Aa or Bb).

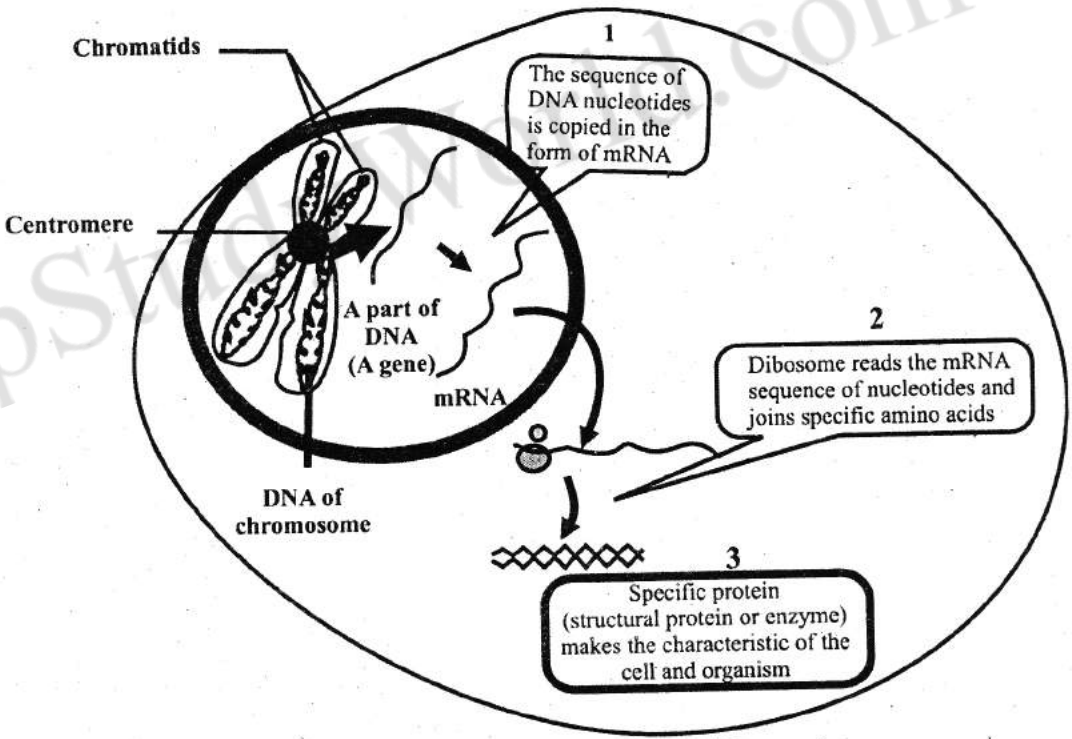


Figure: Working of DNA (Central Dogma)

Alleles:

It means that a gene exists in more than one alternate forms. In the above example, 'A' and 'a' are the two alternate forms of a gene and 'B' and 'b' are the alternate forms of another gene. The alternate forms of a gene are called alleles.

Location of Alleles:

If an individual has Aa gene pair, 'A' and 'a' are the alleles of one another. In this individual, allele 'A' is located on one of the two homologous chromosomes and the allele 'a' is on the other chromosome.

Separation of Alleles:

When chromosomes separate during meiosis, alleles also separate and each gamete gets one of the two alleles. When gametes of both parents unite, the zygote (and the offspring also) receives one allele from each parent.

GENOTYPE AND ITS TYPES

Genotype:

The specific combination of genes in an individual is known as genotype.

Types of Genotype:

It is of two types:

1. Homozygous
2. Heterozygous

Example:

Albinism:

It is a condition in which normal body pigments are absent in an individual.

Alleles:

Like other traits, it is also controlled by one pair of genes. We can represent the two alleles of the pair as 'A' and 'a'.

Possible Combinations:

Three combinations i.e. genotypes are possible for these two alleles:

- AA
- Aa
- aa

Grouping of Genotypes:

These genotypes can be grouped into two types.

Homozygous Genotype:

The genotype in which the gene pair contains two identical alleles (AAor aa), is called homozygous genotype.

Heterozygous Genotype:

The genotype in which the gene pair contains two different alleles (Aa), is called heterozygous genotype.

Dominant Allele:

When in the heterozygous condition one allele masks or prevents the expression of the other, it is called the dominant allele. The dominant alleles are represented by capital letters.

Recessive Allele:

The allele which is not expressed is called recessive. The recessive alleles are represented by lower case letters.

Albinism; A recessive Trait:

Albinism is a recessive trait. It is produced when both alleles are recessive.

In humans, allele 'A' produces normal body pigments while allele 'a' does not produce pigments.

- If genotype is AA or Aa, the individual will produce pigments.
- If genotype is aa, no pigments will be produced and the individual will be albino.

The allele 'A dominates over 'a', because in Aa individual pigments are produced and the effect of 'a' is suppressed by 'A'.

Phenotype:

The expression of this genotype in the form of trait is known as the phenotype.

Example:

Being albino or having normal pigmentation

Q. No. 5 Why did Mendel select pea plant.

SELECTION OF PEA PLANT

Introduction:

Gregor Mendel was a monk (priest) in Austria. He developed the fundamental principles of genetics.

Pea Plant:

Mendel selected pea plant (*Pisum sativum*) to carry out a large number of experiments. He argued that an organism for genetic experiments should have the following features:

Different Traits:

There should be a number of different traits that can be studied.

Contrasting Traits:

The organism should have contrasting traits. Each trait studied in pea plant had two distinct forms.

For example:

The trait of height there should be only two very different phenotypes i.e. tallness and dwarfness.

Different Traits and Their Phenotypes

Traits	Phenoytpes
Seed Shape	Round and Wrinkled
Seed Colour	Yellow and Green
Flower Colour	Purple and White
Pod Shape	Flat and Constricted
Pod Colour	Green and Yellow
Flower position	Axial and Terminal
Stem Length	Long and Short

Self-fertilizing Plant:

The organism (if it is a plant) should be self-fertilizing but cross fertilization should also be possible.

Life Span:

The organism should have a short but fast life cycle.

Cross Fertilization:

Normally, the flowers of pea plant allow self-pollination. Cross pollination can also be done by transferring the pollen grains from the flower on one plant to the flower on another plant.

Mendel's Success:

Mendel's succeeded in his work not only because he selected the right organisms for his experiments but also because he analyzed the results by using the principles of statistics (ratiOS)

Q. No. 6 State and explain Mendel's Law of Segregation.

MENDEL'S LAW OF SEGREGATION

Introduction:

Gregor Mendel was a monk (priest) in Austria. He developed the fundamental principles of genetics.

Selection of plant:

Mendel selected pea plant (*Pisum sativum*) to carry out a large number of experiments.

Statement:

In each organism, the genes are present in pairs. During gamete formation, the genes (alleles) of each pair segregate from each other and each gamete receives one gene from the pair. When the gametes of male and female parents unite, the resulting offspring again gets the genes in pairs.

Selection of Phenotype:

Mendel studied the inheritance of seed shape first.

Monohybrid Cross:

He crossed two plants having one contrasting trait i.e. seed shape. A cross in which only one trait is studied at a time, is called as a monohybrid cross.

Cross Fertilization of True Breeding:

Mendel crossed a true-breeding round-seeded plant with a true-breeding wrinkled seeded plant.

P1 and F1 Generation:

The parental generation is denoted as P1 generation. The offspring of P1 generation are F1 generation (first filial).

Result:

All resulting seeds of the next generation were round.

Conclusion:

Mendel declared the trait "round Seeds" as dominant, while "wrinkled seeds" as recessive.

Self Fertilization of F1:

The following year, Mendel planted these seeds and allowed the new plants to self-fertilize. The cross in F1 generation produces F2 generation (second filial).

Results:

As a result, he got obtained:

Total seeds = 7324
Round seeds = 5474
Wrinkled seeds = 850

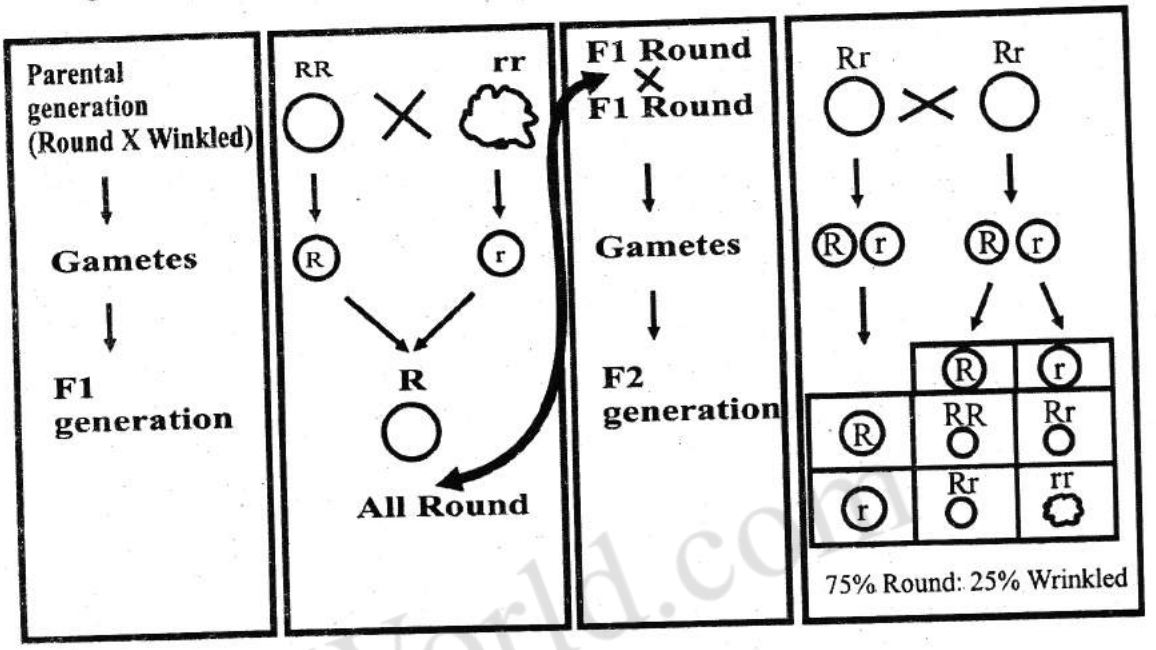
Ratio	Round	:	Wrinkled
	3	:	1

Experiments on Tall and Short Plants:

Similarly, when "true-breeding" tall plants were crossed with "true-breeding" short plants, all offspring of F1 were tall plants i.e. tallness was a dominant trait. When members of F1 generation were self-fertilized, Mendel got the ratio of tall to short plants in F2 as 3:1.

Conclusion:

Mendel concluded that the traits under study were controlled by discrete (separable) factors or genes.



Q. No. 7 State and explain Mendel's Law of Independent Assortment.

MENDEL'S LAW OF INDEPENDENT ASSORTMENT

Introduction:

Gregor Mendel was a monk (priest) in Austria. He developed the fundamental principles of genetics.

Selection of Plant:

Mendel selected pea plant (*Pisum sativum*) to carry out a large number of experiments.

Statement:

The alleles of a gene pair segregate (get separated and distributed to gametes) independently from the alleles of other gene pairs.

Explanation:

Mendel studied two contrasting traits at a time. Such crosses are called dihybrid crosses.

Selection of Phenotypes:

He performed experiments on two seed traits:

Seed shape:

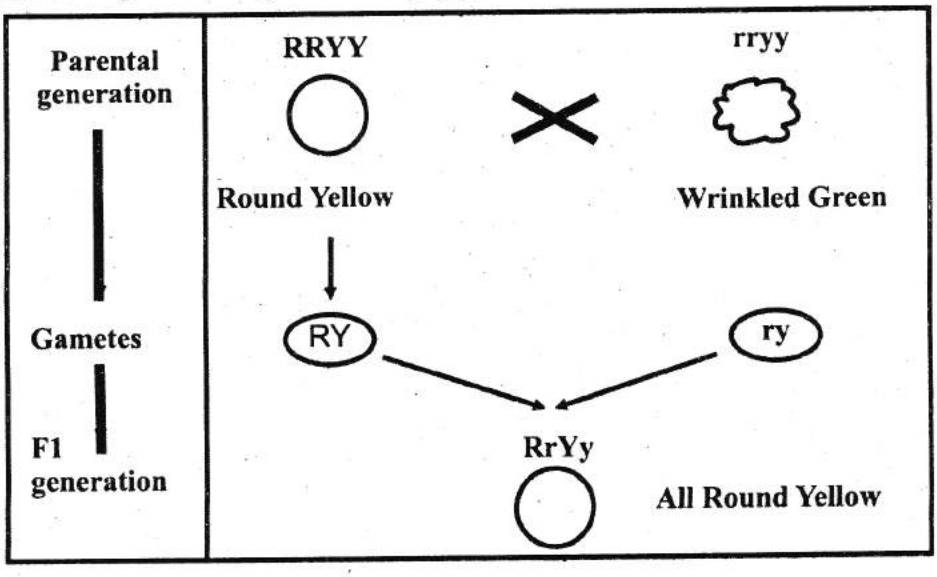
The trait of round seeds, controlled by allele R, was parental dominant over wrinkled controlled by allele r) seeds.

Seed colour

Yellow seed colour controlled by Y was dominant over green controlled by y.

Cross Fertilization of True Breeding:

Mendel crossed a true- breeding plant-that had round yellow seeds (RRYY) with a true breeding plant having wrinkled green seeds (rryy).

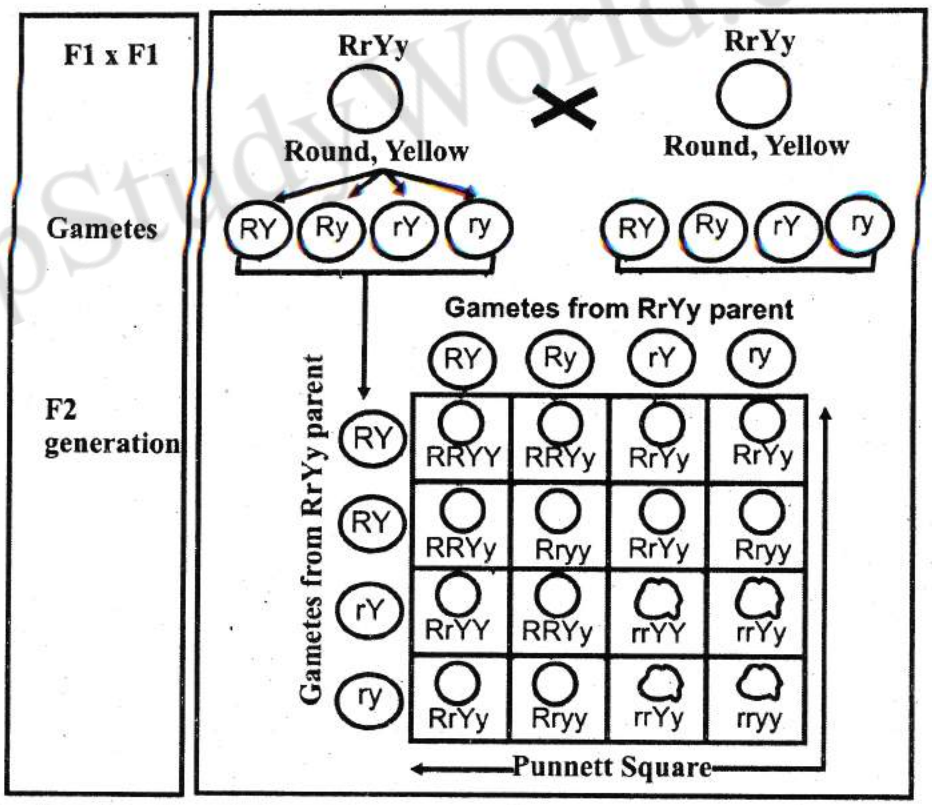


Results:

All seeds in F1 generation were round yellow.

Self Fertilization of F1:

When F1 seeds grew into plants, they were self-fertilized.



Results:

This cross produced seeds with four phenotypes.

Round yellow seeds = 315
Round green seeds = 108
Wrinkled yellow seeds = 101
Wrinkled green seeds = 32

Phenotypic Ratio:

The ratio of these phenotypes was 9:3:3:1.

Conclusion:

Mendel concluded that the two traits i.e. seed shape and seed colour are not tied with each other. The segregation of 'R' and 'r' alleles happens independently of the segregation of 'Y' and 'y' alleles. From this, Mendel concluded that different traits are inherited independently of one another.

Q. No. 8 Write a note on Punnett Square.

PUNNETT SQUARE

Introduction:

Punnett square is named after R. C. Punnett who was an English mathematician.

Definition:

The diagram that is used to predict an outcome of a particular cross or breeding experiment is called Punnett square.

Determination of Gametes:

The gametes of both parents having all possible genetic set-ups are determined.

Usage of Checker Boarb:

A checker board is used to cross all the possible gametes of one parent with all the gametes of other parent.

Advantage:

A biologist can find all the possible genotypes of off springs.

Q. No. 9 Write a note on co-dominance.

CO-DOMINANCE

Introduction:

After the discovery of Mendel's work, scientists began experiments on the genetics of various organisms. These experiments proved that all the traits in organisms do not follow Mendel's laws. For example, it was found that there are many traits which are controlled by more than one pair of genes. Similarly for many traits there are more than two alleles in a gene pair.

Definition:

The situation where two different alleles of a gene pair express themselves completely, instead of showing a dominant-recessive relationship is called co-dominance.

Phenotype of Heterozygous:

As a result, the heterozygous organism shows a phenotype that is different from both homozygous parents.

Example:

Expression of Human Blood Group AB:

The ABO blood group system is controlled by the gene 'I'. This gene has three alleles:

- I^A
- I^B
- i

Blood Group A:
The allele I^A produces antigen A in blood and the phenotype is blood group A.

Blood Group B:
The allele I^B produces antigen B in blood and the phenotype is blood group B.

Blood Group O:
The allele i does not produce any antigen and the phenotype is blood group O.

Blood Group AB:
The alleles I^A and I^B are dominant over i. When there is a heterozygous genotype of $I^A I^B$, each of the two alleles produces the respective antigen and neither of them dominates over the other.

Genotype	Antigen produced	Phenotype	Relationship between Alleles
$I^A I^A$ or $I^A i$	Antigen A	Blood Group A	Allele I^A is dominant over i
$I^B I^B$ or $I^B i$	Antigen B	Blood Group B	Allele I^B is dominant over i
ii	No Antigen	Blood Group O	Allele I is recessive
$I^A I^B$	Antigen A & Antigen B	Blood Group AB	Alleles I^A and I^B are co-dominant

Q. No. 10 Write a note on incomplete dominance.

INCOMPLETE DOMINANCE

Definition:

The situation where, in heterozygous genotypes, both the alleles express as a blend (mixture) and neither allele is dominant over the other is called incomplete dominance.

Intermediate Phenotype:

As a result of this blending, an intermediate phenotype is expressed.

Example:

In Four 0 Clock plants, there are three flower colours:

- Red
- Pink
- White

There is no specific gene responsible for producing pink flowers.

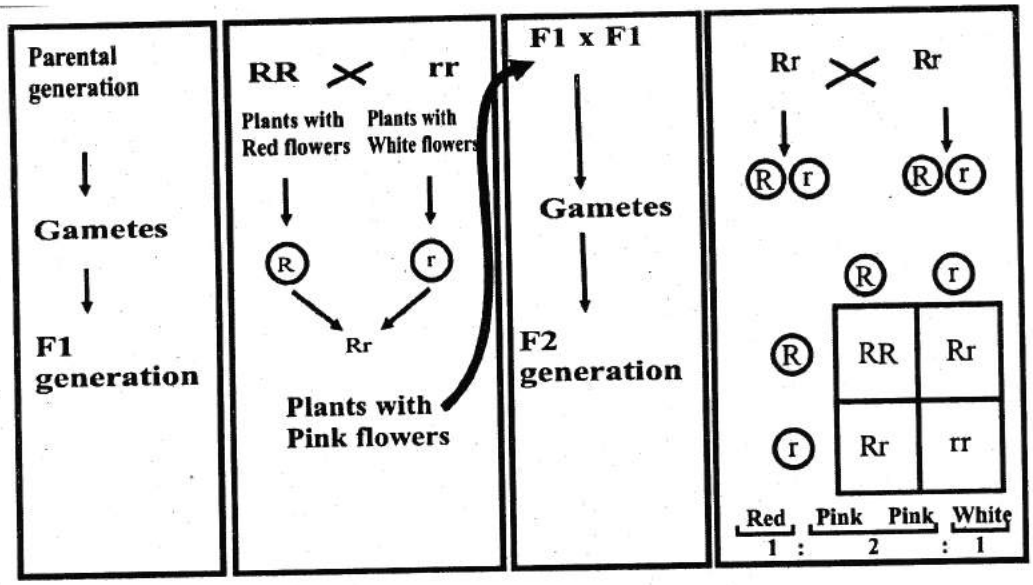
Explanation:

In four a clock plant, the trait of flower colour is controlled by two alleles 'R and r'.

- The true breeding red flower plants have RR alleles.
- The true breeding white flower plants have rr alleles.

Cross Fertilization of True Breeding:

A homozygous red flowered plant (RR) is crossed with homozygous white flowered plant (rr).



Result:

The heterozygous (Rr) plants of F1 generation produce pink flowers.

Conclusion:

Pink is a blend of red and white colours. This result clearly indicates that neither of the red flower allele (R) and white flower allele (r) is dominant.

Self Fertilization of F1:

When two heterozygous plants with pink flowers (Rr) are crossed, F2 generation shows phenotypes of red, pink and white flowers in the ratio 1:2:1.

Q. No. 11 Define variations. Discuss its sources.

VARIATIONS

Introduction:

Sexual reproduction produces variations in the next generation. No two individuals resulting from separate fertilizations are genetically identical.

Definition:

The differences among the individuals of the same species are called variations.

SOURCES OF VARIATIONS

The main sources of variations in sexually reproducing populations are as follow:

Genetic Recombinations:

The genetic recombination produced through crossing over occurring during meiosis results in gametes with variations.

Mutations:

Mutations which are the sudden changes in the structure of DNA are important source of variations. Mutations also happen during gametes formation through meiosis.

Random Fertilization of Gametes:

During fertilization, one of the millions of sperms combines with a single egg. The chance involved in this combination also act as the source of variations.

Gene Flow:

The movement of genes from one population to another is called as gene flow. It is also an important source of variations.

Different Combinations of Chromosomes:

Variations are also caused by different combinations of chromosomes in gametes and then in zygote.

In the case of humans, the possible number of chromosomal combinations at fertilization is 70,368,744,177,664. In other words, a couple can produce more than 70 trillion genetically different children.

Q. No. 12 Differentiate between discontinuous and continuous variations.

DIFFERENCE BETWEEN DISCONTINUOUS AND CONTINUOUS VARIATIONS

Discontinuous Variations	Continuous Variations
Phenotypes: The individuals of a population either have distinct phenotypes, which can be easily distinguished from each other. ***Genes:*** Discontinuous variations are controlled by the alleles of a single gene pair. ***Environmental Effect:*** The environment has little effect on this type of variations. ***Examples:*** Blood Groups: In human population, an individual has one of the four distinct phenotypes of blood groups (A, B, AB or O) and cannot have in between. ***Other examples are:*** • Tongue rolling • Person with six fingers of hand or foot	***Phenotypes:*** In continuous variations, the phenotypes show a complete range of measurements from one extreme to the other. ***Genes:*** Continuous variations are controlled by many genes. ***Environmental Factors:*** Continuous variations are often affected by environmental factors. ***Examples:*** Height: In every human population, the individuals have a range of heights (from very small to tall). No population can show only two or three distinct heights. ***Other examples are:*** • Weight • Feet size • Intelligence

Q. No. !3 Discuss that variations lead to evolution. Explain role of Charles Darwin.

VARIATIONS LEAD TO EVOLUTION

Definition:

The change in the characteristics of a population or species of organisms over the course of generations is called organic evolution or biological evolution.

Explanation:

The evolutionary changes are always inheritable. The changes in an individual are not considered as evolution, because evolution refers to populations and not to individuals.

Processes of Organic Evolution:

Organic evolution includes two major processes:

- Alteration in genetic characteristics (traits) of a type of organism over time
- Creation of new types of organisms from a single type

Contribution of C. de Buffon:

French biologist C. de Buffon (1707-1788) was the first to hint at evolution.

Contribution of Lamarck:

J. de Lamarck (1744-1829) was the first to propose a mechanism of evolution. Lamarck's ideas were soon rejected due to the vagueness of the mechanisms he proposed.

The study of evolution determines the ancestry and relationships among different kinds of organisms.

Theory of Special Creation:

This theory states that:

"All living things had been created in their current form only a few thousand years ago."

- This was an anti-evolution idea.

Scientific Research:

The scientific work in eighteenth century led to the idea that living things might change as well.

ROLE OF CHARLES DARWIN

Charles Darwin (1809-1882) proposed the mechanism of organic evolution in 1838. It was called as "The Theory of Natural Selection". Darwin proposed this theory after his 5-year voyage on the HMS (His Majesty's Ship) Beagle.

Publication:

He also published a book on "The Origin of Species by means of Natural Selection" in 1859.

Acceptance:

Darwin's theory of evolution was not widely accepted because of lack of sufficient evidence. Modern evolutionary theory began in the late 1920s and early 1930s. Some scientists proved that the theory of natural selection and Mendelian genetics are the same ideas just as Darwin had proposed.

Mechanism of Evolution

Variations:

Almost every population contains several variations for the characteristics of its members. In other words, there are morphological and physiological variations in all populations.

Natural Selection:

Natural selection is the process by which the better genetic variations become more common in successive generations of a population.

Adaptations:

Different populations face different environments and they have to adapt to different conditions.

Survival of the Fittest:

The central concept of natural selection is the evolutionary fitness of an organism. Fitness means an organism's ability to survive and reproduce. Organisms produce more offspring than can survive and these offspring vary in fitness. These conditions produce struggle for survival among the organisms of population. The organisms with favourable variations are able to reproduce and pass these variations to their next generations. On the other hand, the rate of the transmission of unfavourable to next generations is low.

Selection of Variations:

The favourable variations are "selected for" their transmission to next generations, while the unfavourable variations are "selected against" their transmission to next generations.

Natural Selection in Rats:

A mouse population with variations in skin colour.

- Light coloured
- Medium coloured
- Dark coloured

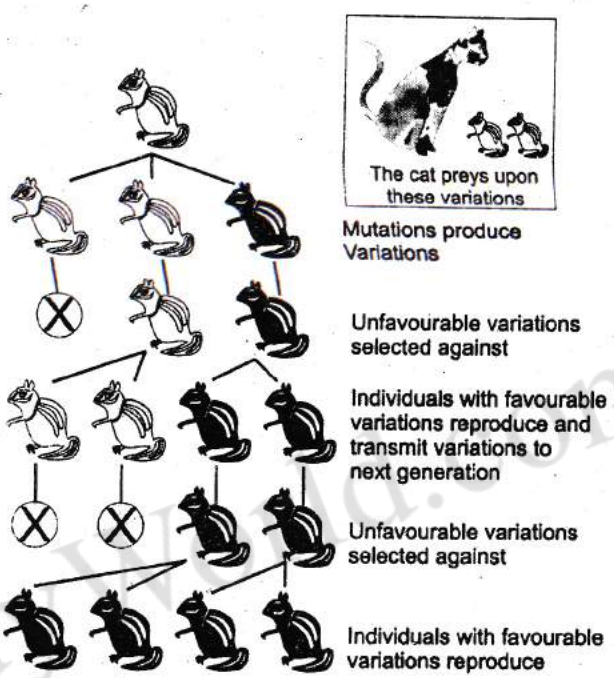


Figure: Natural Selection in Rats

Cat preys upon light and medium coloured mouse. In first generation, light coloured mouse is preyed upon by cat. Only medium and dark coloured mouse can make their next generations. In next generation, population again contains light, medium and dark coloured mouse. Cat preys upon the light and medium coloured mouse. Now only the dark coloured mouse make new generation. If this happens in many generations, the dark coloured (favourable variation) mouse in the population.

Outcome of Natural Selection:

As a result of natural selection, the allele that gives more fitness of characteristics (favourable variations) than other alleles becomes more common within population. So, the individuals with favourable variations become a major part of population while the individuals with harmful or unfavourable variations become rarer.

NATURAL SELECTION IN MOTHS

In England, the moths had two variations:

- Dark coloured moths
- White coloured moths

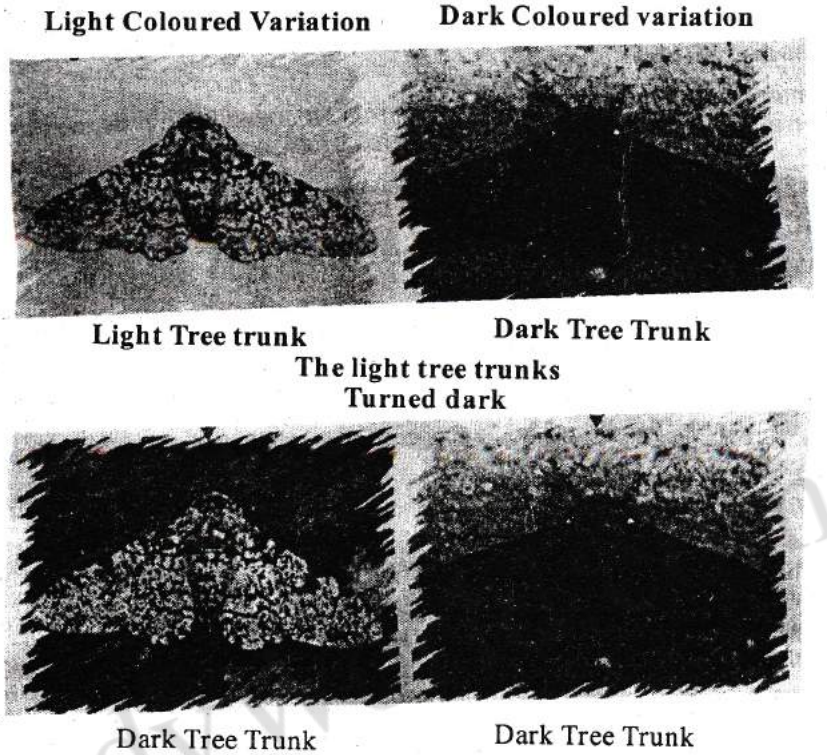


Figure: White and Dark Coloured Moths

The moths used to rest on the light coloured tree trunks on which white lichens had grown. In the 19th century when industries were established in England, the lichens on tree trunks died due to polluted air and the naked tree trunks turned dark. Now the white moth variation became harmful because a white moth resting on a dark tree trunk was easily visible to the predatory birds. The natural selection selected dark moths to reproduce. In this way dark coloured moth became more common and at last the white moths disappeared from population. In this case, the dark colour variation in moth may be considered an adaptation to environment.

Q. No. 14 Write a note on artificial selection.

ARTIFICIAL SELECTION

Introduction:

The term "artificial selection" was expressed by the Persian scientist Abu Rayhan Biruni in the 11th century. Charles Darwin also used this term in his work on natural selection.

Darwin's Observations:

Darwin noted that many domesticated animals and plants had special properties that were developed by:

- Intentional breeding among individuals with desirable characteristics
- Discouraging the breeding of individuals with less desirable characteristics

Task:

In artificial selection, humans favour specific variations for selection while in natural selection the environment selects or rejects variations.

Definition:

The intentional breeding between individuals for certain traits or combination of traits is called artificial selection or selective breeding.

Revolution:

Selective breeding has revolutionized agricultural and livestock production throughout the world. Animals or having desirable characteristics are selected for breeding. In this way, many new generations with desirable characteristics are produced.

Breeds:

The bred animals are as breeds in artificial selection are called breeds.

Cultivars:

The bred plants in artificial selection are known as varieties or cultivars.

Examples:

Numerous breeds of the following animals have been produced by artificial selection:

- Sheep for wool
- Goat for meat
- Cow for milk
- Hen for eggs

Plant Varieties:

Similarly many plant varieties (cultivars) have been produced for better quantity and quality of:

- Cereals
- Fruits
- Vegetables

Plants Varieties of Wild Mustard:

- Kohlrabi
- Kale
- Cabbage
- Broccoli
- Cauliflower

REVIEW QUESTION:

MULTIPLE CHOICE QUESTIONS

1. **An organism's expressed physical trait, such as seed colour or pod shape, is called its**
   (a) Genotype (b) Phenotype (c) Karyotype (d) Physical type
2. **An organism has two different alleles for a single trait. Its genotype is said to be:**
   (a) Homozygous (b) Heterozygous (c) Hemizygous (d) Homologous
3. **In the cross-pollination between a true-breeding yellow pod plant and true-breeding green pod plant, where green pod colour is dominant, the resulting offsprings (F1 generation) will be:**
   (a) ¼ green, ¾ yellow (b) All yellow
   (c) ¼ yellow, ¾ green (d) All green
4. **How many genetically different kinds of gametes an individual with genotype AAbb can produce?**
   (a) 1 (b) 2 (c) 4 (d) 8
5. **Which of the following statements regarding genes is FALSE?**
   (a) Genes are located on chromosomes
   (b) Genes consist of a long sequence of DNA
   (c) A gene contains information for the production of a protein
   (d) Each cell contains a single copy of every gene
6. **Mendel's primary contribution to our understanding of inheritance was:**
   (a) The idea that genes are found on chromosomes
   (b) Explanation of the patterns of inheritance
   (c) The discovery of alleles
   (d) Determining that informations contained in DNA are for protein synthesis
7. **A purple-flowered pea plant has the genotype PP, which of the following statement about this plant is FALSE?**
   (a) Its phenotype will be white flowers
   (b) It has a homozygous dominant genotype
   (c) When bred to a white-flowered plant, all offspring will be purple flowered
   (d) All the gametes produced will have the same flower colour allele
8. **Charles Darwin proposed that organisms produce many more off spring than could possible survive on the limited amount of resources available to them. According to Darwin, the offspring that are most likely to survive are those that:**
   (a) Are born first and grow fastest (b) Are largest and most aggressive
   (c) Have no natural predators (d) Are best adapted to the environment

ANSWER KEY

Q.No.	Ans	Q.No.	Ans	Q.No.	Ans	Q.No.	Ans
1	b	2	b	3	d	4	A
5	d	6	b	7	a	8	d

SHORT QUESTIONS

1. **Define genotype and phenotype.**
   Consult Long Question No. 4
2. **What do you mean by dominant and recessive alleles?**
   Consult Long Question No. 4
3. **What are the homozygous and heterozygous genotypes?**
   Consult Long Question No. 4
4. **Differentiate between natural and artificial selection.**
   Consult Long Question No. 13 and 14

UNDERSTANDING THE CONCEPT

1. **Describe the structure of chromatin.**
   Consult Long Question No. 1
2. **Describe Mendel's law of segregation.**
   Consult Long Question No. 6
3. **Explain how Model proved the law of independent assortment.**
   Consult Long Question No. 7
4. **How would you prove that variations lead to evolution?**
   Consult Long Question No. 13
5. **Explain the phenomenon of incomplete dominance with the help of example.**
   Consult Long Question No. 10
6. **What do you mean by co-dominance. Give an example.**
   Consult Long Question No. 9

THE TERMS TO KNOW

Allele:

The alternative form of a gene

Artificial selection:

Selective breeding; intentional breeding between individuals for certain traits or combination of traits

Breeds:

The animals which are bred through artificial selection

Chromatin:

The chemical material that make the structure of the chromosome

Co-dominance:

The situation where two alleles of a gene pair express their traits independently instead of showing a dominant-recessive relationship

Cultivar:

The plants which are bred through artificial selection

Dihybrid cross:

A genetic cross in which two pairs of contrasting traits are studied

Dominant:

The trait that appears in the offsprings of a cross between two homozygous individuals showing contrasting form of the trait

Gene:

Unit of inheritance; consists of the length of DNA that contains specific instructions for the synthesis of a protein molecule

Genotype:

The specific combination of genes in an individual; may be homozygous or heterozygous

Heterozygous:

The genotype that has two different alleles of a trait

Histone:

The protein present in the structure of the chromosome

Homologous chromosomes:

A pair of chromosomes having the same size and shape and carrying alleles for the same trait

Homozygous:

Having two identical alleles of a trait

Incomplete dominance:

A type of inheritance in which neither of the pair of contrasting alleles is dominant over the other and the heterozygous individual is intermediate in phenotype

Inheritance:

The transmission of characteristics from parents to offsprings

Locus:

Plural Loci; the locations or positions of genes on chromosomes

Monohybrid cross:

A genetic cross in which only one pair of contrasting traits is studied

Mutation:

Changes in chromosomes or DNA (gene); produces variations intraits

Natural selection:

The process in which organisms with favourable variations survive and produce more offsprings than less well-adapted organisms

Nucleosome:

The structure formed by the wrapping of DNA around histone proteins

Organic evolution:

Biological evolution; The modification of the characteristics in the species or populations of organisms during their descent, generation by generation

Phenotype:

The expression of the genotype in the form of trait

Recessive trait:

The trait which is masked in the offspring of a cross between two homozygous individuals showing contrasting forms of the trait

Trait:

The characteristics which are controlled and transmitted to next generation through genes

True-breeding:

The homozygous individual

Variations:

A characteristic in an individual that differs from the typical characteristics of other individuals of the same species